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OVERSIGHT HEARING TO RECEIVE TESTIMONY ON AGENT ORANGE

HEARING

BEFORE THE

SUBCOMMITTEE ON MEDICAL FACILITIES AND BENEFITS

OF THE

COMMITTEE ON VETERANS' AFFAIRS HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

SECOND SESSION

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A Brief Review of the Use, Environmental Fate and Toxicology of Herbicide Blue

USE OF HERBICIDE BLUE

Herbicide Blue was a defoliant extensively used in South Vietnam from Jan... 1962 through October 1971. Blue was a clear yellow-tan liquid that was soluble... water and was formulated to contain the acid and sodium salt of cacodylic a... (hydroxydimethylarsine oxide). The percentages of the formulation were:

Cacodylic acid	...
Sodium cacodylate	...
Surfactant	...
Sodium chloride	...
Antiform agent	...

The cacodylic acid and sodium cacodylate contained 15.4 percent arsenic in ... form of a pentavalent organic arsenical (16). One gallon of Blue was formulated ... contain 3.1 pounds of active (plant toxic) ingredients. The term "Herbicide Bl... was first applied to powdered cacodylic acid first procured in 1961 and used in So... Vietnam from 1962 through 1964. It was a commercially-available product fr... Diamond Shamrock Company, and approximately 10,000 pounds were used dur... this three-year period. After 1964, "Herbicide Blue" referred to the liquid formu... tion discussed above. This produce, known commercially as Phytar 560G, was pr... cured from Ansul Company (2) and approximately 3,538,710 pounds of the acti... ingredient were disseminated in South Vietnam (15). Approximately half of a... Herbicide Blue sprayed in South Vietnam was used in crop destruction missions... e.g., on cereal and grain crops. The majority of crop destruction missions we... conducted by C-123 fixed-wing aircraft assigned to the Air Force RANCH HAN... Operation. These aircraft were assigned to the bases of Tan Son Nhut, Bien Hoa, D... Nang and Phu Cat. The remaining half of the Herbicide Blue sprayed in Vietnam... was used in defoliation or in control of grass around base perimeters. The majority of this Blue was applied by helicopters. The helicopters and their crews that applied Blue around base perimeters were selected on an "as available" basis. Thus, crew members representing all branches of the military may have handled the herbicide.

ENVIRONMENTAL FATE

The fate of organoarsenicals in plants and soils has been extensively investigated (1, 6, 13). Cacodylic acid and sodium cacodylate are nonselective foliar contact-type herbicides. They are rapidly absorbed (within several hours) by the leaves and stems and readily translocated within the plant. Death of the plant usually occurs within 24 hours. Cacodylic acid is apparently very stable within plant cells; i.e., it does not appear to be metabolized. The mechanism of phytotoxicity is not known. Herbicidal spray that is intercepted by soil (either directly or washed from leaves with rain) is "deactivated" by absorption to soil colloids. While the initial soil absorption of cacodylic acid or sodium cacodylate is rapid (hours), long-term changes (within weeks) result in redistribution of the water-soluble cacodylic acid into less soluble factions associated with aluminum and iron. Thus, the lack of residual phytotoxicity permits reseeding to occur immediately.

From 1968 through 1970, the United States Air Force applied 4,395 gallons of Herbicide Blue (13,625 pounds active ingredient) to an area of approximately 240 acres (Test Area C-52A, Eglin AFB FL), in the course of developing and testing spray-equipment for use in the RANCH HAND Operation in South Vietnam. Lehn et al (9) conducted an ecological study of the fate of the arsenicals on the area. They found that little or no movement of arsenicals occurred into the adjacent aquatic ecosystems, nor was any adverse effects found in these aquatic systems. Moreover, Young (14) reported that rapid revegetation and establishment of insect and animal populations occurred in this area once spray operations terminated.

TOXICOLOGY

Chemically, arsenic is one of the most versatile and mysterious of all the elements. Arsenic forms alloys with metals, but also reacts readily with carbon, hydrogen and oxygen. Its nonmetallic properties permit it to form divalent acids. Thus, it should not be surprising that arsenicals exhibit a wide range of toxicity and biological behavior. Generally, inorganic arsenicals are far more toxic than organic arsenicals. Arsenic trioxide has an oral LD_{50} of mg/kg in rats while the oral LD_{50} of cacodylic acid is 2,500 mg/kg and the oral LD_{50} of Herbicide Blue is 3,000 mg/kg (16).

It has been established that animals and man receive a daily intake of arsenic which varies with geographical location and type of diet (10). The chemical nature of the arsenic from most dietary sources is largely unkown. Consumption of "natural" sources of arsenic from water, fish and vegetation has resulted in human urine "naturally" containing concentrations of 15 parts per billion (ppb) cacodylic acid (13).

Arsenic compounds can be absorbed by any route although the usual entry is by ingestion (10). The distribution, excretion and possible metabolism of cacodylic acid has been investigated in rats following single and repeated intravenous injection, intratracheal instillation or oral gavage (11). The extent and rate of lung absorption was greater than gastrointestinal absorption.

Concentrations of cacodylic acid in the liver and whole blood were higher after peroral dosing than intravenous administration. The excretion of cacodylic acid was very rapid with more than 60 percent of the dose being excreted in the urine after intravenous and intratrachael administration and only minor amounts being excreted in the feces. Cacodylic acid did not appear to be converted from organic to inorganic arsenical. These studies in rats by Sevens et al (11) did not indicate any six-related differences in the distribution of cacodylic acid. It was found, however, that cacodylic acid can pass the placental barrier just prior to parturition, achieving levels in the whole blood of the fetus comparable to the maternal animal.

Inorganic forms of arsenic (e.g., sodium arsenate) have been shown to be teratogenic (birth-deforming) in experimental animals (4). The inorganic forms of arsenic (e.g., arsenic trioxide) have been associated with respiratory cancer in man (8). However, studies with cacodylic acid have not concluded that it is either teratogenic, mutagenic or carcinogenic in laboratory animals or man (5, 10). Innes et al (7) bioassayed cacodylic acid for tumorigenicity in mice and judged it to be negative following oral administration at 46 mg/kg for 18 months. Perhaps the major reason that cacodylic acid (and hence Herbicide Blue) has shown only limited toxicity symptoms in man and animals is because of its organic form. Crecilius (3) found that in man inorganic forms of arsenic ingested in the diet were rapidly methylated to methylarsonic acid and cacodylic acid prior to excretion. When organoarsenic forms were ingested, they were quickly excreted in the urine without changes in the chemical form. Crecelius (3) also noted that in man the half-lives were in the order of 10 hours for inorganic arsenic and 30 hours for the methylated arsenic forms. Peoples (10) has concluded that methylation of inorganic arsenicals causes a great reduction in toxicity and is a true detoxification process in man. These data are important to observations made by Tarrant and Allard (12) that forest workers spraying cacodylic acid had levels of arsenic in their urine in excess of 0.3 ppm at least once during a nine-week study period. However, no health problems were encountered in the study group that could be classified as arsenic poisoning.

SUMMARY

Herbicide Blue, an organic arsenical herbicide, was extensively used in South Vietnam for crop destruction programs and control of grassy vegetation around base perimeters. The toxicity of the active ingredients, the acid and sodium salt of cacodylic acid, is considered low. In man, these active ingredients are rapidly excreted, unchanged in the urine. Limited studies with cacodylic acid have concluded that it is not a teratogen, mutagen or carcinogen in laboratory animals or man.

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Mr. SATTERFIELD. Very well.

The first panel today will be Dr. Samuel Epstein of the University of Illinois, Dr. Jean Stellman of Columbia University, and Dr. Steven Stellman of the American Cancer Society. As I stated in my preliminary remarks, we will be happy to receive your statements either in full or, if you wish, to paraphrase in any way that suits you. We will refrain from questions until the three of you have completed the statements you wish to make to us.

Dr. Epstein, if you would lead off, we would appreciate it very much.

STATEMENT OF DR. SAMUEL S. EPSTEIN, SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF ILLINOIS

Dr. EPSTEIN. Congressman Satterfield, Congressman Daschle, distinguished members of the Subcommittee on Medical Facilities and Benefits, my name is Samuel Epstein, and I am professor of occupational and environmental medicine and director of toxicology of the NIOSH Educational Resource Center at the School of Public Health, University of Illinois Medical Center, Chicago. A statement on my professional qualifications, background, and publications is attached to this testimony—Appendix 1.

As an M.D. and human and experimental pathologist and toxicologist, I have for some three decades studied the hazardous effects of chemicals and chemical pollutants, including pesticides, herbicides, industrial chemicals, drugs, and food additives, in air, water, food and the workplace, with particular reference to delayed or chronic toxic effects, notably cancer, reproductive and genetic effects. I have over 200 scientific publications and five books in these areas.

Furthermore, over the past decade, I have had increasing involvement in the interface between science and public policy, as exemplified by membership of a wide range of Federal advisory and expert committees, and by consultantships to Congress, including the Senate Committee on Public Works.

Arsenic Formulations Analyses

Bollscy!:

Crystal Chemical Company.

1525 North Post Oak Rd.

Houston TX

713-682-1221

Mrs. Sanders

Gunter

4 Bdroom

875-2434

$160 - 170

BLUE 560G (12 years)

→ .002% arsenite

Current 560

.04% arsenite

• Ed Woolson

18 Jul 80

31 Jul 80

Call to Ed Woolson X 301-344-3076

Arsenical Composition: Herbicide Blue - Phytar 560 G

	Phytar 560		Blue	
Arsenite	3800 ppm	(.38%)	225 ppm	(.02%)
Cacodylic	250,000 ppm	(25%)	136,000 ppm	(13.6%)
MSMA MAA	87,000	(8.7%)	52,000 ppm	(5.2%)
Methane Arsonic Acid	Total Arsenic 34%			18.2%